EM375 MECHANICAL ENGINEERING EXPERIMENTATION

MEASUREMENTS AND STATISTICAL VARIATION
"MEASUREMENTS LAB"

PURPOSE: The objective of this laboratory is to observe that repeated measurements give a variety of results for which statistical treatments are useful. You will conduct two experiments. In the first, you will use vernier calipers that are simple but precise length measuring tools. In the second, you will perform repeated experiments and observe how variation inevitably occurs. The experiment is to collect information about the firing characteristics of a small slingshot. This slingshot is a geometric model of the full-scale slingshot you will use later this semester (in the project) to "wipe out your prof". The better your measurements today, the better your chance of hitting the prof later on!

PROCEDURE: There are three sets of data to be collected for this lab. You will collect your data by working individually or in groups of three or four, as detailed below.

Ball Data. Using the vernier calipers, each ***individual*** student will measure and record the diameters of 35 valve balls. For each ball you will separately measure and record the diameter at the joining seam and the diameter away from the joining seam. You will also measure and record the mass of each ball.

Miscellaneous Data. ***As a group*** you will measure and record the masses and dimensions of some components that will be used later for the project. You will record:

- Small tube length and mass
- Large tube length and mass
- Mass of small launcher pouch
- Mass of large launcher pouch

Impact Distance. An important part of the final project is determining how far the projectile will travel for a given launch angle and initial stretch ratio of the rubber tubing on the slingshot. Since the full scale slingshot will not be used until the project field day, you will be creating a mathematical model of the slingshot that predicts the range. You will use the data from today's lab to determine an important characteristic of the launcher. You will record the launch angle and impact distance measurements needed to do this in today's lab, but you will analyze the results later.

Each group will be given a launcher and a unique launch angle & stretch ratio combination ($l < 3.0$). Group members will collect data on impact distance for at least 35 separate launches (use a number of different balls). The data from all groups will be pooled for the entire class.

$l = L / L_O$

L = stretched length of the rubber tubing

L_O = unstretched length of the tubing

Do not exceed $l = 3$. You will be shown how to ensure your ball is launched at the same angle each time.

DATA REDUCTION AND REPORTING: The report is an individual report in the "Memo Report" format. Use the "Format and Style Guide for Technical Reports," Mechanical Engineering Department, Aug 1998 as a reference. Data reduction will be done using Mathcad. In your report, create and label separate column tables for each of the following sets of measurements: Ball diameters (two); ball mass; slingshot range. Table(s) must fully identify the observed data and its source, as well as calculated data and results.

Ball Data.

1. Calculate the mean, standard deviation and 95% confidence level for each measurement.

2. Use the procedure in the "Tests Between Two Populations and Samples" to determine if there is a statistical basis for stating that the seams cause a difference in the diameter of the balls.

Miscellaneous Data.

No data reduction is required. Just show a table of measurements. You will use this information later this semester.

Impact Distance.

1. Calculate the mean, standard deviation, and standard deviation of the mean for all the launches made by your group. Use the Thompson-τ test to reject any bad data points.

2. What are the 95% and 99% confidence levels of impact distance for your data?

3. Discuss the possible causes of variation in this data.

COLLABORATION: Measuring the ball dimensions – individual. All other data collection for this lab is by group effort. The data reduction will be individual. Report is individual.

Hints on memo report writing: Report all final results in the letter so that your "boss" can just read the letter and know the results. Write in active voice and do not use the first person. Carefully read the "HINT" on page three of the style guide. Use the Mathcad worksheets as appendices and make them easy to follow for someone who is versed in Mathcad. The lab handout does not form part of your report, but it should be cited as a reference. However, the handout is to be attached as the last sheet of your report.